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ABSTRACT

Despite suggestions for incorporating students' experiences into school math lessons, mathematics education seems to be the last bastion of formalism. This paper reports on a sociocultural study of the use of students' personal experiences in early childhood elementary mathematics lessons. This study documents the use of students' personal out-of-school experiences in classroom math and other subjects and investigates barriers that may prevent such linking. The following questions are addressed: (1) To what extent do teachers currently link school math and students' personal out-of-school experiences? and (2) What influences the use of such linking? The study included observations of lessons in mathematics, language arts, and social studies in public, private, and homeschool settings. Despite recommendations in the literature, results showed that teachers rarely link students' personal experiences to math concepts. Linking is more common in language arts and social studies than in mathematics lessons. This study found that the gap between school math and the life experiences of students is established early in elementary school. It is therefore suggested that any reforms need to be implemented in the early grades as well as higher grades. (PVD)

Linking Life Experiences to Classroom Math

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Statement of the research problem

"Linking Life Experiences to Classroom Math" is a sociocultural study of the use of students' personal experiences in early childhood - elementary mathematics lessons. This study documents the use of students' personal out-of-school experiences in classroom math and other subjects and investigates barriers that may prevent such linking. The following questions are addressed in this paper:

1) To what extent do teachers currently link school math and students' personal out-of-school experiences?

2) What influences the use of such linking?

Despite a number of studies documenting students' uses of mathematics outside school and a number of theorists calling for linking the two, it remains unclear why mathematics is still taught formalistically. That is the purpose of this present research.

As I have reflected on my experiences in education, I have speculated about their implications for teacher education. One of the areas on which I have speculated is that of the "whole language" approach to writing. This writing process approach to composition builds the abstract on the foundation of children's own experiences and interests. It has required new pedagogical techniques and a new framework for envisioning what learning can be. Having seen the positive transformation that the whole language approach has had on writing education, I began to ask whether this approach could be translated into mathematics education. Rather than trying to 'prove' that a "whole math" approach is a valid one, I set out to study whether it was used and if not, what might prevent it from being implemented. Realizing a quick-fix to math education is too simplistic, I wanted to understand the complexity of factors which impinge on math education. In doing so, I have conceptualized mathematics education as an interaction of cultural, organizational, and individual factors in the social context of a classroom. In this paper, I focus on the cultural factors since I found them to be the most distinct influence on the extent of linking students' out of school knowledge with math lessons.

The need to integrate school and life

A brief overview of some twentieth century United States educators' views reveals a consistent concern for the isolation of school lessons from everyday life. At the turn of the century, John Dewey decried this distance:

> From the standpoint of the child, the great waste in the school comes from his inability to utilize the experiences he gets outside the school in any complete and free way within the school itself; while, on the other hand, he is unable to apply in daily life what he is learning in school. That is the isolation of the school - its isolation from life. (Dewey 1905 (1900), 76)

Writing a few decades after Dewey, Willard Waller noted that "The teacher represents the adult group, ever the enemy of the spontaneous life of groups of children. The teacher represents the formal curriculum, and his interest is in imposing that curriculum upon the children in the form of tasks; pupils are much more interested in life in their own world than in the desiccated bits of adult life which teachers have to offer (Waller 1965 (1932), 195)." What Willard Waller had to say in the 1930s often remains true of math education today. As Resnick notes,

> It seems that children treat arithmetic class as a setting in which to learn rules, but are somehow discouraged from bringing to school their informally acquired knowledge about numbers. This tendency for school knowledge to be disconnected from real life is not limited to mathematics - although it is particularly easy to draw clear examples from mathematics

> learning. The process of schooling seems to encourage the idea that the 'game of school' is to learn symbolic rules of various kinds, that there is not supposed to be much continuity between what one knows outside school and what one learns in school. There is growing evidence, then, that not only may schooling not contribute in a direct and obvious way to performance outside school, but also that knowledge acquired outside school is not always used to support in-school learning. Schooling is coming to look increasingly isolated from the rest of what we do (Resnick 1987, 15).

A number of writers have called for reducing this gap by better utilizing students' outside knowledge in school. In summarizing reform efforts, Peterson concluded that collaboration, encouraging student thinking, and integrating school knowledge with outside experiences are some of the reforms being emphasized today (Peterson 1994). Courtney Cazden charges teachers "to find connections, in this case not in texts, but in contexts, to integrate what may easily stand as isolated school and home experiences (Cazden 1988, 76)."

Leading theorists in ethnomathematics[1] have also advocated a closer alliance of street mathematics[2] with school mathematics, and have begun to suggest ways for street math to be used in school. Saxe and Gearhart (1988) note an example in which street knowledge of money helped students understand the decimal system. The most prolific writer in the field of street math is Nunes, formerly Carraher. She indicates that street math can enhance relevance and interest in school math by using a number of real situations to pose problems to be solved before an abstract concept is dealt with in the classroom. She also notes that using natural language to describe a street situation helps the transition from tool to object (Nunes 1992). "We suggest that educators should question the practice of treating mathematical systems as formal subjects from the outset and should instead seek ways of introducing these systems in contexts which allow them to be sustained by human daily sense (Carraher 1985, 28)." For all of the researchers cited, the concern is one of integrating school and life outside the school so that they reinforce each other in enhancing student learning.

The need for this study

Despite suggestions for including students' experiences in school math lessons, K-12 mathematics education seems to have remained largely unchanged. Unlike language arts and social studies, math education seems to be the last bastion of formalism. In the whole language approach to language arts, students learn grammar and composition in the process of writing about experiences which have personal meaning. Social studies texts encourage students to contrast and compare their personal experiences with those of other people and communities. Students are sometimes encouraged to bring resources from home which are relevant to the topics being studied in language arts or social studies. Of the thirteen National Council of Teachers of Mathematics Standards for revising elementary school mathematics curriculum, one standard specifically focuses on mathematical connections. While the Standards have drawn attention to the need for connections within mathematics, there has been less focus on students' out-of-school experiences. Accused of being too abstract in the past, math textbooks now contain frequent real-life problems to solve but they are problems contrived by others rather than those emerging in students' own experiences. For all the emphasis on relevance, students are rarely encouraged to tie

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[1] Ethnomathematics is the study of peoples' ways of doing math in their everyday lives.
[2] Street mathematics is a categorical term used in ethnomathematics for the mathematics which people use in their everyday lives.

classroom math to their own personal life experiences, particularly those had outside of the classroom.

The literature is in agreement on the fact that street and school math tend to be separated and should be linked more. It further suggests that street math could be combined with abstract school math concepts to tell a story of a particular situation in real life while showing how an abstract school math concept transcends the immediate particulars of the street math situation. The issue seems to be how to get the school and life experiences to work synergetically so that each informs and reinforces the other. Why is this not done in mathematics, when it is increasingly being utilized in other subjects? Despite a number of studies documenting students' uses of mathematics outside school and the number of theorists calling for linking the two, it remains unclear why mathematics is still taught formalistically.

Background theory

Culturally, school knowledge is often considered to be superior and therefore different from the rest of life. School knowledge is "official" knowledge which is authoritative compared to other knowledge which is unofficial and unauthorized. This is especially true of math. Researchers such as Frankenstein have noted that one reason why math education has remained isolated from everyday experiences is that mathematics has been conceived as abstract, theoretical, formal, and universal knowledge which exists outside life, rather than emerging from social practice (Frankenstein 1987). As a result, everyday activities such as measuring and estimating are not considered to "really" be math. Math is also thought to be objective and true as contrasted with the subjective and hypothetical nature of knowledge in language arts and social studies. There is a certainty to math, with clearly right and wrong answers, that elevates it above the everyday. The sanctity of math as pure and insular may both allow and encourage its isolation from personal experience.

A brief overview of the history of the nature of mathematics will help explain the culture from which present day mathematics education evolved. Throughout the history of mathematics there has been a tension between an otherworldly and pure conception of mathematics and a conception of it as a practical activity. When math is viewed as otherworldy, efforts are made to keep it pure by isolating it from everyday life. In this view, math consists of Truth which exists "out there." There are first principles upon which other math truths are based. On the other hand, when math is viewed as a practical activity of this world, the emphasis is on math in the everyday world. In this view, truth is dependent on the context and the people involved, not on some otherworldly pure principles. Morris Kline summarizes the centuries-old debate as being one of what role the external world plays in mathematical knowledge. He sees the spectrum as extending from Plato's insistence on the fickleness of observations of the external world to one which insists that both reason and experience must be included in mathematical knowledge.

Why has mathematics experienced the tensions of Platonism and Aristotelianism? What are the larger issues at play here? What are the social ramifications of Platonists clinging to the authority of eternal truths or Aristotelianists emphasizing the social nature of knowledge? An examination of cultural theories of education may help put the history of United States mathematics education in perspective to understand the isolation of school mathematics. Sociologists of knowledge and of teaching have noted distinct characteristics of school and life knowledges and how those knowledges are constructed and maintained. Writing in 1936, Karl Mannheim paved the way for later work by Basil Bernstein as to the relative isolation of academic knowledge from life experiences. In describing the characteristics of the thought of the intelligentsia, he notes "its relative remoteness from the open conflicts of everyday life: hence it is also 'scholastic' in this sense, i.e. academic and lifeless. This type of thought does not arise primarily from the struggle with concrete problems of life nor from trial and error, nor from experiences in mastering nature and

society, but rather much more from its own need for systematization (Mannheim 1970 (1936), 11)."

Basil Bernstein sees strong boundaries between academic and lay knowledge as well as between different disciplines as all helping to maintain spheres of power and authority (Bernstein 1973). In schools, "framing" defines the boundaries between everyday knowledge and school knowledge (Bernstein 1973, 89). Weak framing allows knowledge from outside to be linked with school knowledge whereas strong framing insulates school knowledge from the outside.

> In a sense, educational knowledge is uncommonsense knowledge. It is knowledge freed from the particular, the local .... Now this immediately raises the question of the relationship between the uncommonsense knowledge of the school and the *commonsense* knowledge, everyday community knowledge, of the pupil, his family and his peer group. This formulation invites us to ask how strong are the frames of educational knowledge in relation to experiential, community-based non-school knowledge? I suggest that the frames of the collection code, very early in the child's life, socialize him into knowledge frames which discourage connections with everyday realities, or that there is a highly selective screening of the connection. Through such socialization, the pupil soon learns what of the outside may be brought into the pedagogical frame. Such framing also makes of educational knowledge something not ordinary or mundane, but something esoteric, which gives a special significance to those who possess it. (Bernstein 1973, 99)

According to Bernstein, to link school and everyday knowledge also means that social relationships are linked more closely. "Relaxed frames not only change the nature of the authority relationships by increasing the rights of the taught, they can also weaken or blur the boundary between what may or may not be taught, and so *more* of the teacher and taught is likely to enter this pedagogical frame.... The concept of relatively weak boundary maintenance which is the core principle of integrated codes is realized both in the structuring of educational knowledge *and* in the organization of the social relationships (Bernstein 1973, 102)." Individual motives and identities are valued in situations with weak boundaries and control is negotiable and less overt, rather than residing in the hierarchical status of teachers over students. In these situations of weaker boundaries, verbal exploration of individual interests is encouraged. Not only are students' personal experiences included more in subjects with relaxed frames, but there is more intimacy as teachers' and students' personal lives are included in lessons.

A researcher who has studied how subjects are classified differently is Susan Stodolsky. Her research has examined how subject matter influences methodology and what is taught. In her research on math and social studies, Stodolsky found that teaching methods and involvement were very different for the two subjects (Stodolsky 1988). She found that math, being more required and evaluated than social studies, entailed fewer concrete experiences and less variety of teaching than social studies. The "arbitrariness and fuzziness" of social studies permitted more variety of instruction than did math. In subsequent research with Grossman, Stodolsky expanded on her earlier work on differences between subjects to explain the rigidity of math as taught in the classroom. Whereas both math and language arts have high status in schools, math is perceived to be very sequential, demanding that skills be taught in a certain order and in a certain time period. "English teachers, for example, talked about the 'permissive' nature of the subject matter, whereas math teachers spoke of what they perceived to be the constraints of the content. Math teachers commented frequently on the demands for coverage of a well-established curriculum, of having 'to get to a certain point by a certain time,' as one

informant described. . . . While all teachers felt free to decide on the teaching techniques to use in their classes, math teachers felt significantly less freedom to decide on the content of their classes than did teachers of the other four academic subjects [language arts, social studies, science, foreign languages] (Grossman and Stodolsky 1995, 7)." "In a sequential subject, such as math, teachers may feel they cannot put students at risk by altering their teaching practices or instructional content, possibly leaving students unprepared for subsequent courses. Changes in course content may not carry the same risk for students in English (Stodolsky and Grossman 1995, 245)." These differences in teachers' conceptions of mathematics and other subjects are understandable in light of the history of mathematics as a cultural category which has been more strongly framed to keep math isolated and elevated from life and other disciplines.

Clarification of personal experiences

In this study, I observed the extent to which teachers currently link school content and students' personal out-of-school experiences. To clarify the terms used here, personal out-of-school life experiences are ones which a specific student[3] has actually experienced outside of school, as contrasted with hypothetical experiences which a particular student has not personally experienced. For example, a student, Caitlin, who has actually ridden a commuter train has had that as a personal out-of-school life experience; whereas for a class of students of whom none have taken a train trip, reference to a train trip would be considered a hypothetical experience, not a personal one. A vicarious personal experience is one which a student has heard a fellow student relate.

The following chart of contrasting types of math experiences may clarify their differences:

EXAMPLES OF EXPERIENCES WITH TIMETABLES

	hypothetical	*personal*
in school	answering questions about a textbook problem involving a fictitious classroom schedule	working with a group to decide and post the new classroom schedule so everyone can see when recess, subjects, lunch occur
out of school	using a train timetable to answer questions about times between stations, with no intention of actually riding the train	using a commuter train timetable to arrive in time for a soccer game vicarious: students using this fellow student's experience on a commuter train as a math problem in school

When Caitlin's teacher introduces a lesson on calculating time intervals, he could ask if anyone has gone on a trip where he or she had to read train or bus or plane

[3] While I also consider teachers' personal experiences to be valuable additions to a lesson, this research focuses specifically on students' personal out of school experiences. This is not to deny that teachers are a valuable part of the community in the classroom but rather to narrow the focus of this study.

schedules. Caitlin might volunteer her story and the class use her information in its calculations. For the rest of the class, Caitlin's personal experience becomes a vicarious out-of-school experience which they can use to link to school math. No longer is calculating time intervals something which only happens in math class. Now the entire class links classroom math to Caitlin's personal experience riding a commuter train.

Methods of inquiry, data sources

The present study includes observations of lessons in mathematics, language arts, and social studies in three types of school settings: public, private, and homeschool. A fifth grade and a first grade class were observed in each school. Two of the classes were observed sixteen times over an entire semester whereas others, in order to expand my data pool, were observed three to five times over a few weeks. Although I recorded entire lessons, I especially focused on instances when a link was made, was attempted to be made, or (in my view) might have been made. If linking did occur, I documented the contexts in which it did. If linking did not occur, I again documented the contexts. Debriefing sessions were held after each observation session. Member checking by the participating class teachers consisted of debriefing after class observations or having them read my descriptions and respond with any corrections. In addition to the debriefing sessions in which some interview questions were asked and answered, each teacher was interviewed once during the study and once at the end of the study.

1) To answer question one on the extent to which teachers link math and students' personal out-of-school experiences, I used class observations, supplemented by information from interviews with teachers in which I asked about the extent of their linking in math lessons. In observing these classes, I recorded the content of interactions in math, language arts, and social studies lessons, in an effort to note the extent and methods of linking personal experiences in each of the subjects. When I observed linking or potential linking, I tried to record as closely as possible the actual dialogue as well as the context. I also recorded students' behavioral reactions such as raised hands, attention, and posture. Later, I categorized the nature of the linking episodes in each of the subject areas.

2) To investigate the effect of the cultural conception of math on elementary math lessons, examining the boundedness of math as a pure subject, I used a combination of observations and interviews. I observed math, language arts, and social studies to see if there are differences between subjects in linking the school subjects with outside knowledge. This gave me a basis for comparing math teaching to other subjects. If linking is used more significantly in language arts than in math, that is an indication of math being bounded as a pure subject more than language arts. If cultural beliefs about math education are strong barriers to linking students' out-of-school experiences with class math, then I would expect to see differences between the three subjects. If cultural beliefs are the salient constraint, then differences between subjects should remain relatively consistent in the three contexts of public, private, and homeschools.

Findings

Despite recommendations in the literature, the study finds that teachers rarely link students' personal experiences to math concepts. Linking is more common in language arts and social studies than in mathematics lessons. Overall, I did not find teachers linking students' personal out-of-school experiences with classroom mathematics, while they consistently did link in language arts and in social studies, regardless of level or context of elementary schooliing. Indeed, only one teacher used linking in mathematics with enough frequency to be noticeable. Since the action was predominately across subjects, this points to cultural factors as one possible reason that classroom math is isolated from students' personal lives.

Cultural understanding of mathematics: In general, regardless of organizational or individual differences, elementary math was taught in a way that was isolated from students' lives outside of school. There was a prevailing view among the teachers studied that school math and street math do not mix, indicating a strong framing of mathematics education. When I ask why elementary math classrooms do not include students' personal experiences in their study of math concepts, the history of privileging theory above practical experience can be seen as a partial explanation. Despite the differences between Platonism and Aristotelianism, both are based on rationalism. This underlying belief in rationalism throughout the differing strands of philosophy of mathematics suggests that math will be taught as a rational subject which does not need students' personal out-of-school experiences brought into it. Unlike language arts and social studies, in which students' outside knowledge could be used to argue for the validity of an answer, mathematics as understood by the teachers did not allow such subjectivity. In most classrooms, when students were confused, math concepts were explained abstractly rather than with concrete examples from the students' experiences. Overall, the Platonic view of math as abstract, elevated, rational, a priori, and linear prevailed throughout most of these elementary classrooms despite the rhetoric of inservice workshops and efforts of the National Council of Teachers of Mathematics to foster a constructivist approach to math understanding.

Implications for education

Linking of personal experiences may be an important addition to school math lessons. This study specifically focuses on personal out-of-school experiences. Some may ask whether personal experiences, no matter where they are situated, are the important ingredient for making school relevant to students. Certainly, an emphasis on out-of-school experiences pushes schooling beyond what even progressive educators envisioned. Progressive educators who followed Dewey tended to focus on individual and community experiences in the classroom as the link to involve students in school subjects. I see such a focus as continuing the isolation of school learning from the totality of students' lives, which includes both school and out of school. I see students' entire lives as relevant and consider the ultimate learning experiences to be ones where disparate parts of the learners' lives are connected. This does not imply that I do not see value in using classroom experiences. Indeed, I assume they will continue to dominate as hands-on, guided experiences can be very valuable in math education. The thrust of this study, however, was to examine linking students' out-of-school experiences to classroom math as a way of connecting parts of students' lives which typically are not connected in school.

For too long, educators have taught mathematics as disconnected from students' lives. Characterizing and criticizing this teaching is John Taylor Gatto, New York State Teacher of the Year in 1991, who claims, "*The first lesson I teach is confusion.* I teach the un-relating of everything. I teach dis-connections. I teach too much. . . . I teach how to accept confusion as your destiny. That's the first lesson I teach (Gatto 1991, 5)." While I had hypothesized that the gap between school math and the life experiences of pupils grows wider the higher the level of math, this study found that the gap is established early in elementary schooling and therefore suggests that any reforms need to be implemented in early grades as well as higher grades. Rather than our best teachers admitting they teach isolation of knowledges, how can they instead integrate knowledges? This study addresses issues which teacher education will be challenged to address if it is to alter the isolation of knowledges in schools. Rather than a functionalist view of a mathematical technique of including students' personal experiences in math classes, what I am suggesting is socially situating mathematics concepts in the lives of the students. This serves to transform math education from an hour a day of disembodied problems to grounding math concepts in terms of events which exist in time and space and which are personally relevant to the students.

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